130-122

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: David J. Stevens et al.	§	ATTY DOCKET NO.: P-17.95
SERIAL NO.: N/A	§	GROUP NO.: N/A
FILED: Herewith	§	EXAMINER: N/A
TITLE: REACTIVE PERSONNEL PROTECTION SYSTEM	§	

Assistant Commissioner for Patents
Washington, D.C. 20231
ATTN: Group Director, Group_____ (M.P.E.P. § 1002.02(c))

PETITION TO MAKE SPECIAL
UNDER M.P.E.P. § 708.02 and 1190 OG 83

1. Petition

Applicant hereby petitions to make this application, which involves countering terroristic activity, special.

2. Declaration Explaining Relationship to Countering Terrorism

The attached application is directed toward an invention which contributes to countering terrorism by providing the rapid (almost instantaneous) erection of a safety shield to prevent loss of life due to detected ballistic projectiles or concussive bomb explosions. The apparatus and method of the invention are expected to operate *proactively*, so that the shield is in place before a detected destructive force arrives at the intended target.

Declaration explaining the relationship of the invention to research in the field of countering terrorism made by the

[ ] Applicant
[X] Attorney

3. Fee

The fee required by 37 C.F.R. 1.17(i) is to be paid by
[X] the attached check for $130.00
[ ] charging Account 07-2400 the sum of $130.00. A duplicate of this petition is attached. A duplicate of this petition is attached.

Respectfully submitted,
GUNN, LEE & MILLER, P.C.

Mark V. Muller

Mark V. Muller, Regis. No. 37,509
300 Convent, Suite 1650
San Antonio, Texas 78205
(210) 222-2336

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Express Mail No.: EM512069707US

429-201 A

Docket No. P-17.95

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): David J. Stevens, Kirk A. Marchand and Thomas J. Warnagiris

For (title): REACTIVE PERSONNEL BALLISTIC PROTECTION SYSTEM

1. Type of Application

This new application is for a(n):

[x] Original (Non-Provisional)
[ ] Design
[ ] Plant
[ ] Divisional
[ ] Continuation
[ ] Continuation-in-part (CIP)

2. Benefit of Prior U.S. Application(s) (35 USC §120 or 35 USC §119(e))

[ ] The new application being transmitted claims the benefit of prior U.S. application(s) and enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed Which Are Required For Filing Date Under 37 CFR §1.53(b) (Regular) or 37 CFR §1.153 (Design) Application

21 Pages of specifications
6 Pages of claims
1 Pages of abstract
6 Sheets of drawing
[ ] formal
[X] informal

4. Additional papers enclosed

[ ] Preliminary Amendment
[X] Information Disclosure Statement
[X] Form PTO-1449
[X] Citations
[ ] Declaration of Biological Deposit
[ ] Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence
[ ] Authorization of Attorney(s) to Accept and Follow Instructions from Representative
[ ] Special Comments
[X] Other: Petition to Make Special Under M.P.E.P. § 708.02 and 1190 OG 83

5. Declaration or oath

[X] Enclosed, executed by
- [X] inventor(s).
- [ ] legal representative of inventor(s). 37 CFR §1.42 OR §1.43
- [ ] joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.
  - [ ] this is the petition required by 37 CFR §1.47 and the statement required by 37 CFR §1.47 is also attached.

[ ] Not Enclosed.
- [ ] Application is made by a person authorized under 37 CFR §1.41(c) on behalf of all the above named inventor(s). The declaration or oath, along with the surcharge required by 37 CFR §1.16(e) can be filed subsequently.
  - [ ] Showing that the filing is authorized.

6. Inventorship Statement

The inventorship for all the claims in this application are:

[X] The same

[ ] Not the same. An explanation, including the ownership of the various claims at the time the **last** claimed invention was made,
[ ] is submitted. [ ] will be submitted.

7. Language

[X] English

[ ] non-English
- [ ] the attached translation is a verified translation. 37 CFR 1.52(d).

8. Assignment

[X] An assignment of the invention to:
[X] is attached. [ ] will follow.

[X] A separate "ASSIGNMENT COVER LETTER ACCOMPANYING NEW PATENT APPLICATION" is also attached.

9. Certified Copy

Certified copy(ies) of application(s)

(Country)	(Appln. No.)	(Filed)
(Country)	(Appln. No.)	(Filed)

from which priority is claimed:

[ ] is(are) attached.
[ ] will follow.

10. Fee Calculation (37 CFR §1.16)

A. [X] **Regular application**

CLAIMS AS FILED

	Number filed	Number Extra	Rate	Total
Basic Fee				$770.00
Total Claims	20 - 24 =	4	x $ 22.00	$ 88.00
Independent Claims (37 CFR 1.16(b))	3 - 3 =	0	x $ 80.00	
Multiple dependent claim(s), if any (37 CFR 1.16(d))			$260.00	

[ ] Amendment canceling extra claims enclosed.
[ ] Amendment deleting multiple dependencies enclosed.
[ ] Fee for extra claims is not being paid at this time.

Filing Fee Calculation $858.00

B. [ ] **Design application**
($320.00--37 CFR §1.16(f))

Filing Fee Calculation $_____

C. [ ] **Plant application**
($530.00--37 CFR §1.16(g))

Filing Fee Calculation $_____

11. Small Entity Statement(s)

[X] Verified Statement(s) that this is a filing by a small entity under 37 CFR §1.9 and §1.27 is(are) attached.

Filing Fee Calculation (50% of **A**, **B** or **C** above) $429.00

12. Request for International-Type Search (37 CFR §1.104(d))

[ ] Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made At This Time

[ ] Not Enclosed
[ ] No filing fee is to be paid at this time.
[X] Enclosed

[X]	basic filing fee	$429.00
[X]	recording assignment ($40.00; 37 CFR §1.21(h))	40.00
[ ]	petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached. ($120.00; CFR §1.47 and §1.17(h))	$_____
[ ]	for processing an application with a specification in a non-English language. ($30.00; 37 CFR §1.52(d) and §1.17(k)	$_____
[ ]	processing and retention fee ($120.00; 37 CFR §1.53(d) and §1.21(l))	$_____
[ ]	fee for international-type search report ($30.00; 37 CFR §1.21(e)	$_____
	Total fees enclosed	**$469.00**

14. Method of Payment of Fees

[X] Check in amount of $469.00
[ ] Charge Account No. 07-2400 in the amount of $_____. A duplicate of this transmittal is attached.

15. Authorization to Charge Additional Fees

[X] The Commissioner is hereby authorized to charge the following additional fees by this paper during the entire pendency of this application to Account No. 07-2400.
- [X] 37 CFR §1.16 (a), (f) or (g) (filing fees)
- [X] 37 CFR §1.16 (b), (c) and (d) (presentation of extra claims)
- [ ] 37 CFR §1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- [X] 37 CFR §1.17 (application processing fees)
- [ ] 37 CFR §1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 CFR §1.311(b))

16. Instructions As To Overpayment

[ ] credit Account No. 07-2400
[X] refund

Mark V. Muller

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[X] **Incorporation by reference of added pages**

[ ] Plus Added Pages For New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

[X] Plus Added Pages for Papers Referred To In Items 5 and 8 Above

Number of pages added 7

[X] Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added 150

[X] Plus "Assignment Cover Letter Accompanying New Application":

Number of pages added 1

[ ] **Statement Where No Further Pages Added**

[ ] This transmittal ends with this page.

GUNN, LEE & MILLER, P.C.

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Twentieth Anniversary 1977 1997

P-17.95 (00033.143)

May 12, 1997

Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: U.S. Patent Application, entitled "REACTIVE PERSONNEL PROTECTION SYSTEM", Inventors; David J. Stevens, Kirk A. Marchand, and Thomas J. Warnagiris

Dear Sir:

Enclosed for filing as the above referenced patent application are the following documents:

1. New Application Transmittal;
2. Petition to Make Special;
3. Declaration and Power of Attorney;
4. Patent Application (Specification, Claims, Abstract);
5. Six sheets of drawings;
6. Assignment with Cover Sheet;
7. Small Entity Statement;
8. Information Disclosure Statement with Copies of References;
9. Check in the amount of $599.00;
10. Return postcard acknowledging receipt.

If you have any questions or require anything additional, please contact the undersigned.

Sincerely,

Mark V. Muller

MARK V. MULLER

MVM/mjn
Enclosures
x:\mk\swri\p-17.95\ptofilng.ltr

Express Mail No.: EM512069707US

Applicant or Patentee: David J. Stevens, Kirk A. Marchand and Thomas J. Warnagiris
Serial or Patent No.:
Attorney's Docket No.: P-17.95
Date Filed or Issued: herewith
For: Reactive Personnel Protection System

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) and 1.27(d)) - NONPROFIT ORGANIZATION

I hereby declare that I am an official empowered to act on behalf of the nonprofit organization identified below:

NAME OF ORGANIZATION: Southwest Research Institute
ADDRESS OF ORGANIZATION: 6220 Culebra Road (P.O. Drawer 28510)
San Antonio, Texas 78284
TYPE OF ORGANIZATION: TAX EXEMPT UNDER INTERNAL REVENUE SERVICE CODE (26 USC 501(c)(3))

I hereby declare that the nonprofit organization identified above qualifies as a nonprofit organization as defined in 37 CFR 1.9(e) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code with regard to the invention entitled Reactive Personal Ballistic Protection System by inventor(s) David J. Stevens, Kirk A. Marchand and Thomas J. Warnagiris described in

[X] the specification filed herewith
[ ] application serial no. _____, filed _____.

I hereby declare that rights under contract or law have been conveyed to and remain with the nonprofit organization with regard to the above identified invention.

If the rights held by the nonprofit organization are not exclusive, each individual, concern or organization having rights to the inventions listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME: N/A

ADDRESS: N/A

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING John W. McLeod

TITLE IN ORGANIZATION General Counsel

ADDRESS OF PERSON SIGNING 6220 Culebra Road, P.O. Drawer 28510
San Antonio, Texas 78228-0510

SIGNATURE John W. McLeod DATE 4-28-97

Express Mail No.: EM512069707US

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

TITLE

REACTIVE PERSONNEL PROTECTION SYSTEM

INVENTORS

DAVID J. STEVENS
KIRK A. MARCHAND
THOMAS J. WARNAGIRIS

ASSIGNEE

SOUTHWEST RESEARCH INSTITUTE

Express Mail NO.: EM512069707US

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates generally to the field of apparatus and methods for shielding the body from hostile gunshot activity or bomb explosions. More particularly, this invention relates to an apparatus and method for the automated introduction of a protective, inflatable shield between the concussive force of a bomb blast or the impact energy of a projectile, and the body of the person at which it is directed.

2. DESCRIPTION OF THE RELATED ART

Many different approaches to the protection of personnel from life-threatening attacks exist. Examples of such approaches include bullet-proof glass, concrete and steel building structures, armored cars, bullet-proof jackets, and others. The particular avenue taken depends on whether the person is stationary, located in a vehicle, located within a building, or is required to maintain mobility outside the confines of any specific stationary structure.

Many law enforcement agencies have the designated task of protecting public figures from terroristic attacks. Most often this protection is achieved through some combination of passive personnel armor (e.g., previously mentioned bullet-proof vests, etc.), identification and control of potential sniper vantage points, and passive protection such as shields, bullet-proof glass, armor plates, and other devices mentioned previously. Since public

figures often desire unrestricted access to the public and commensurate high visibility, traditional ballistic screens and placement of protective personnel in close proximity are often not practical or effective. Therefore, a need exists for an unobtrusive, reactive device that provides adequate ballistic protection. This need can be satisfied by detecting an incoming pistol or rifle ballistic projectile, discriminating that projectile from other potential airborne particles or objects, and activation/deployment of a protective device, prior to the arrival of the projectile at the designated target.

A search of the prior art did not disclose any patents that read directly on the claims of the instant invention, however, the following U.S. patents were considered related:

PATENT NO.	INVENTOR	ISSUE DATE
3,861,710	Okubo	January 21, 1975
4,856,436	Campbell	August 15, 1989
5,327,811	Price et al.	July 12, 1994
4,782,735	Mui et al.	November 8, 1988

Okubo discloses a vehicular safety system having an obstacle detector and an impact detector. These detectors are coupled to a single, inflatable air bag which can be deployed by the activity of either detector. One of the detectors is a Doppler radar for predicting collision with the vehicle, and the other senses impact at the moment it occurs between the vehicle and another object. The air bag is incrementally inflated by signals emanating from

either of these detectors, being interposed between the occupants of the vehicle and destructive interior vehicle surfaces.

Campbell discloses an invention to automatically cover electronic equipment for protection from automatic sprinkler systems and other sources of water during the activation of a fire alarm. The cover is deployed by the automatic expansion of spring-loaded telescopic arms which respond to a manual or electronic alarm signal. The cover can be manually reset by rotating and compressing the telescopic arm system to replace the cover into its enclosure. The object of this invention is to protect expensive equipment from fire, smoke, and water damage resulting from fire in the immediate vicinity of the equipment.

Price et al. describes an adaptable bullet-proof vest which makes use of SPECTRA® materials components. The body armor vest consists of several pieces of SPECTRA SHIELD® material (consisting of resin bonded fibers) sewn into woven ballistic SPECTRA® fiber fabric. This combination of woven and non-woven SPECTRA® components creates increased levels of protection for a bullet-proof vest, while simultaneously reducing weight and bulk.

Finally, **Mui et al.** speaks to a bullet-proof protection apparatus consisting of a full-length, inflatable body shield which can be carried in a portable fashion. The shield consists of an encased, inflatable mattress which is deployed by manual activation of a pressurized gas source. This invention anticipates the use, storage, and re-use of the mattress.

SUMMARY OF THE INVENTION

Public officials, military personnel, and civilian leaders are often exposed to a wide range of physical threats. While the related devices described in the previous section are somewhat effective in detecting destructive terroristic activity, each approach has its own limitations. The most likely threat areas currently encountered are those provided by high explosives, detonated within a building or at some short distance from a building, and small arms fire (e.g. an assassination attempt). The invention herein described incorporates a combination of systems to produce a robust, unobtrusive, and easily installed apparatus which acts to defeat these threats after detonation of a bomb, or discharge of a weapon.

The present invention is a reactive personnel protection system which acts by detecting the presence of a destructive force or object and interposing a protective shield between personnel under attack and the force in an almost instantaneous fashion. Several embodiments of the invention are provided, namely, detection of an incoming small arms projectile, or detection of a concussive blast triggered by a bomb explosion. In either case, a triggering mechanism is provided to rapidly inflate an air bag fabricated from SPECTRA®, KEVLAR®, or similar materials. This air bag is rapidly inflated and interposed between the projectile or concussive force and the person to be protected so as to either deflect the projectile or reduce the effects of the concussive

force.

In the case of projectile detection and protection, a radar-based bullet detection system with anti-jamming electronics is used to detect the presence of an incoming small arms projectile and determine its path of travel. A bi-static radar system is used to detect the Doppler shift signature of any detected objects to reliably determine the presence of a bullet, and discriminate between the bullet and any other rapidly moving object in the vicinity. Additionally, signal processing circuitry and algorithms are used to help differentiate between projectiles and noise or other extraneous signals to prevent false alarms. Once the presence of a ballistic object is confirmed, a control unit activates a gas generation device, which in turn rapidly inflates an anti-ballistic air bag.

In the case of a concussive blast triggered by a bomb explosion, the detection mechanism consists of blast pressure gauges or other devices which are sensitive to rapid changes in acceleration (if mounted to a physical structure), and/or air pressure (e.g. the concussive wave front which accompanies an explosion). These blast pressure gauges are placed at a suitable distance from, and on a periphery around, the personnel to be protected. Other devices, such as magnetostrictive transducers, ultrasonic transducers, accelerometers, and other mechanical and/or electro-mechanical sensors can also be applied to sense the occurrence of a concussive explosion. Signal analysis hardware is

used to discriminate and verify the presence of a concussive blast wave front. Redundant verification is also provided, to minimize the likelihood of accidental deployment. Further, anti-jamming electronics are used to provide immunity to electronic noise which may otherwise render the system inoperable. Of course, such redundant verification and anti-jamming electronic systems are also applied to the aforementioned ballistic object detection system.

In the case of either detection system, any type of destructive force confirmation signal resulting therefrom is used to bring about the rapid inflation of an anti-ballistic air bag. This air bag is specially fabricated from ultra-high molecular weight polyethylene, such as SPECTRA®, KEVLAR®, or similar materials which can be used to redirect or lessen the approach of an unwanted destructive object or force. The overall size of the inflated bag depends upon the desired level of protection and the time needed to deploy the bag. Vents are incorporated into the bag to control stress in the bag material during deployment, and also to determine the length of deployment time. Prior to deployment, the air bag is housed in an unobtrusive container having a metallic base plate, and held in place with a pinching bar. The container has a frangible surface through which the air bag can be rapidly deployed.

A gas generation system (also housed in the container holding the air bag) is used to fill and deploy the anti-ballistic air bag. Multiple air bags and/or multiple generators may also be employed,

depending on the particular system protection requirements.

It should be noted that the present invention is distinctly different from existing sniper detection systems, which are designed to locate the source of a ballistic projectile after the target has been hit, so that return fire or other offensive actions can be taken. These systems typically make use of Doppler radar or acoustic technology, and do not incorporate any proactive, protective capabilities. The present invention, however, is designed to detect the presence of the projectile during its flight, and before impact.

Therefore, the reactive personnel protection system of the present invention makes use of a radar-based bullet detection system, or a concussive blast detection system, which provides an inflation signal to an anti-ballistic air bag interposed between the approach of an unwanted destructive object and the personnel to be protected. The signal denoting approach of a destructive force is analyzed and confirmed to make sure that it is properly differentiated from noise or other extraneous signals which may be present. The detection system further includes anti-jamming circuitry for electronic noise immunity and redundant verification to help prevent spurious activation of the air bag.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a perspective view of the explosion protection embodiment of the present invention before air bag deployment.

Fig. 1B is a perspective view of the explosion protection embodiment of the present invention after detection of an explosion.

Fig. 2A is a perspective view of the ballistic protection embodiment of the present invention before air bag deployment.

Fig. 2B is a perspective view of the ballistic protection embodiment of the present invention after detection of a ballistic projectile.

Fig. 3 is a three-view depiction of a deployed air bag.

Fig. 4 is a schematic block diagram of a bi-static radar ballistic projectile detection system.

Fig. 5 is a schematic diagram for Doppler-shifted tone detection.

Fig. 6 is a schematic diagram of a gas-generator squib ignition circuit.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to Fig. 1A, a perspective view of the explosion protection embodiment of the present invention can be seen. This view depicts the state of the apparatus of the present invention prior to detection of a concussive (blast) pressure wave. Person (100) is shown seated in a room (90) having doorway opening (80). Pressure wave sensor (50) is placed at some distance away from air bag enclosure (20) sufficient to ensure that pressure wave (70) emanating from explosion (60) will not reach person (100) before

the protective element of reactive personnel protection system (10) can be fully activated.

Referring now to Fig. 1B, the deployed condition of the present invention can be seen. Since sound normally travels at a speed of 1,025 ft./sec. at sea level, and it may take air bag (25) approximately 30 msec. to deploy, the minimum distance that sensor (50) should be placed from enclosure (20), which houses air bag (25), is 50 ft. This gives approximately 20 msec. for the control unit (40) to process the signal provided by sensor (50) via sensor output conduit (55), confirm that the signal indicates the presence of a destructive pressure wave (70), and initiate deployment of air bag (25) via trigger output (30).

Turning now to Fig. 2A, a perspective view of the ballistic protection embodiment of the present invention before the protective element has been deployed can be seen. It has been determined that the best method for detecting the presence of a bullet (130) is radar technology; acoustic-based systems are less reliable and can be defeated by silencers applied to small arms. Doppler radar systems have been used successfully as velocimeters in ballistic applications, and in general, Doppler radar system perform well in noisy and/or geometrically complex environments. The present invention incorporates a bi-static configuration of Doppler radar in which a separate illuminator or transmitter (110) is located at some distance from passive receiver (120). The sensor output conduit (55) from receiver (120) is monitored by

control unit (40) and, after suitable analysis and discrimination, trigger output (30) is activated whenever the presence of bullet (130) is detected and confirmed. Trigger output (30) is sent to enclosure (20), which houses air bag (25) (not shown in this figure).

Turning now to Fig. 2B, the deployed condition of the ballistic protection embodiment of the present invention can be seen. Initial trajectory (140) of bullet (130) has been detected by receiver (120) and air bag (25) has been deployed from enclosure (20). It should be noted that several enclosures (20), housing multiple air bags (25), can also be employed in this embodiment of the invention. Once control unit (40) has determined initial trajectory (140) of bullet (130), then the appropriate air bag (25) can be deployed via trigger output (30). This figure also illustrates intermediate trajectory (150) of bullet (130), after it is redirected by encountering front surface (220) of air bag (25). Bullet (130) is further redirected by rear surface (230) to follow exit trajectory (160). As mentioned previously, air bag (25) is deployed by control unit (40) so as to interpose a protective shield between the initial trajectory (140) of bullet (130) and person (100).

Lightweight materials, such as DuPont's KEVLAR® and Allied Signal's SPECTRA®, are available as woven fabrics to provide proper anti-ballistic air bag protection. These materials can be sewn or configured in many ways to accommodate ballistic protection

applications; in the present invention, the selected material is formed into air bags similar to those found in automobiles, but of larger size and thickness. The strength to weight ratio of these anti-ballistic fabrics are among the highest available, either man-made or natural.

Turning now to Fig. 3, a three-view depiction of the deployed air bag (25) of the present invention can be seen. After detection and confirmation of a concussive shock wave or ballistic projectile, an activation signal is sent to gas generator (210) so that air bag (25) is inflated within approximately 20-30 msec of receipt. Enclosure (20) has frangible upper surface (260) through which air bag (25) emerges when inflated by gas generator (210). Front surface (220), rear surface (230), and top surface (245) of air bag (25) are made from SPECTRA®, KEVLAR®, or other similar ultra-high molecular weight polyethylene fabric. Using such construction results in a type of spaced-plate armor system. That is, for a given level of protection, such a multi-plate system results in a lighter protective element, per unit area, than using a single, equivalent layer of the same material.

The inflation of air bag (25) by way of gas generator (210) is also controlled using vents (240) and cross-ties (200). Air bag (25) should optimally be configured to remain effectively inflated and in place for at least two seconds.

The effectiveness of the anti-ballistic air bag (25) in stopping a bullet is a function of the thicknesses of the front

surface (220) and rear surface (230), as well as the distance between them. The mechanical advantage of this spaced-plate system lies in the fact that the front surface (220) slows, deforms, and re-directs the projectile as it passes through; the slower, tumbling projectile is then either halted or further re-directed by the rear surface (230) of air bag (25).

In the present invention, any material of sufficient strength and toughness to significantly re-direct a ballistic projectile along its initial trajectory can be used to construct the air bag (25). However, the preferred embodiment of air bag (25) is constructed from SPECTRA®, due to its strength, ballistic protection properties, and the ease with which it can be used to fabricate the air bag (25). The thickness of the anti-ballistic fabric can be varied and should be chosen to match a particular threat.

The shape and dimensions of inflated air bag (25) can be modified to meet the required level of protection (e.g. projectile size and velocity), along with area coverage requirements. As shown, the inflated anti-ballistic air bag (25) has a pillow shape, and would be sized to cover a typical doorway if used as illustrated in Fig. 1B. That is, the dimensions would be roughly 4 ft. wide by 8 ft. high by 1-1/2 ft. thick at the widest portion. Air bag (25) is continuously attached to a base plate (250), located near the bottom of enclosure (20), and held in place with a pinching bar (not shown) around the periphery of base plate

(250).

The seams of air bag (25) are sewn using SPECTRA® or other, similar fibers, and the structure of air bag (25) is reinforced using cross-ties (200), also of SPECTRA® or similar material so that the air bag (25) deploys vertically, rather than billowing horizontally. The size and position of cross-ties (200) are a function of the size of air bag (25), the required inflation time, and the size of the gas generator (210). Air bag (25) also contains reinforced vents (240) that are sized to control the peak pressure experienced during inflation of air bag (25) and therefore, the peak stress applied to the material used to fabricate air bag (25). Vents (240) located in top surface (245) of air bag (25) also act to provide a downward force which acts against base plate (250) due to vertical jetting of gas expelled through vents (240).

While the system is described as being implemented with SPECTRA® fabric, which is a trademark of the Allied Fibers Division of Allied Signal, Inc., other materials may be used. SPECTRA® fiber is an ultra-high molecular weight polyethylene fiber with high strength and low specific gravity. KEVLAR®, which is a trademark for aramid fiber sold by DuPont, or Dyneema™ can also be used. Also, such materials can be used in combination, such as combining woven ballistic fabric and a non-woven SPECTRA® fiber shield. This method is disclosed in U.S. Pat. No. 5,237,811 issued to **Price, et al.** Any material which is described as an ultra-high

molecular weight polyethylene fiber, or fabric, or any other flexible material of sufficient strength to resist puncture by typical bullet-like projectiles and concussive explosion blasts can be used to implement the air bag of the instant invention.

Gas generator (210) is similar to that found in conventional automobiles, but larger in size and utilizing a faster burning oxidizer component. As illustrated in Fig. 3, a single gas generator (210) is used. However, multiple generators (210) can be used to reduce inflation time and prolong the duration of time during which air bag (25) remains effectively deployed. Gas generator (210) is affixed to base plate (250) and is surrounded by insulation (215) which provides a thermal barrier between gas generator (210), and the nearby base plate (250) and air bag (25).

Turning now to Fig. 4, a schematic block diagram of the present invention, using a bi-static radar detection system for ballistic projectiles, can be seen. In this embodiment of the invention, an analog signal processing system is illustrated, however, a RISC processor or other relatively fast digital computer can also be used to process signals from sensory components in the system to reliably detect the presence of a ballistic projectile or concussive wave front

Power supply (305) is used to supply power to all components employed in the detection, discrimination, and gas generator activation circuits. In this particular embodiment, signal generator (310) supplies a 10.5 GHz signal (normally continuous

wave, but modulation for anti-jamming and noise rejection may be added) to directional coupler (320). The generator signal is then amplified by amplifier (330) and passed to transmitting antenna (340) for illumination of incoming objects. The transmitted signal is applied to the general area surrounding personnel to be protected. Transmitting antennae (340) are operated with approximately 100 milliwatts of power at a frequency of 10.5 GHz. Dedicated receiving antenna (350) is passive. The bi-static system, using a separate transmitting antenna (340) and receiving antenna (350), provides greater received signal isolation and greater detection range by reducing receiver signal overload (due to spatial isolation between the respective antennae). Such a system also provides greater flexibility in shaping detection elevation and azimuth coverage. Receiving antenna (350) output is amplified by low noise amplifier (360) and mixed with a sample of the signal provided by signal generator (310) via directional coupler (320) and mixer (370). The resulting signal, introduced into broadband transformer (380) (North Hill Electronics, Inc. model 0016PA, or equivalent), is a Doppler-shifted beat signal. After passing the beat signal through high pass filter (390) (optimally operating at a 3 dB point of 6 kHz, with maximum rejection of 100 dB at 2 kHz), the signal is then amplified via received signal amplifier (400), further filtered by way of low pass filter (410) (optimally acting at a 3 dB point of 200 kHz, maximum rejection of 100 dB at 600 kHz), further amplified using

signal amplifier (420), and passed on to tone decoder (430). The low noise amplifier (360) should have as low a noise figure as practical without being overly sensitive to in-band intermodulation products. The broadband transformer (380) is not essential to system functionality, but is useful for isolating ground-induced noise and further limiting the received signal bandwidth to the bands of interest. The signal amplifier (400) is a low noise (S/N < 4 dB) amplifier operating at the doppler frequencies (20 to 70kHz). Performance is not critical to the operation of the circuit as long as it provides enough gain with the received signal amplifier (420) to trigger the tone decoder.

Tone decoder (430) responds to a Doppler shift produced by predetermined bullet velocities. The shift is determined by the well known equation $\Delta f = 2Vf_c/C$, where Δf is the doppler shift, V is the velocity, f_c is the CW frequency, and C is the speed of light. The tone decoders can be set for a nominal center frequency and bandwidth (bandwith should be limited to 14% of f_c). The circuit values illustrated in Fig. 5 produce a response frequency which corresponds to the velocity of a 9mm bullet. Tone decoder response time varies with the velocity of the bullet plus many other factors. Another detection method requires designing of a recognition algorithm combined with digital signal processing of the sampled doppler waveform. Much better sensitivity and lower false alarms should be possible than those methods using simple tone decoders, which function adequately and provide a lower cost

approach. Multiple tone decoders (430) (not shown) with overlapping frequency bands can also be used to detect a range of Doppler shift frequencies so that a corresponding range of ballistic projectile velocities can also be detected.

The ballistic protection embodiment of the present invention may be refined by using one or more transmit and receive antennas to produce a Doppler shift from ballistic projectiles entering a well-defined volume of space. Such antennae combinations would be placed in a specific series of locations optimized for ranging and simultaneously reducing the chance of false alarms by signal sources outside the radar field of view.

To overcome jamming which disables destructive force detection, or deliberate activation of the system through use of electromagnetic signals (either spurious or intended), anti-jamming circuitry is also included in the present invention. Various approaches are available, including signal amplitude and frequency coding, as is well known to those skilled in the art. Such coding may include simple sinusoidal amplitude or frequency modulation, which in turn would produce recognizable side bands on a true Doppler-shifted signal; such side bands would not appear as the result of a jamming signal. More sophisticated coding techniques, including signal doping, can also be used, but should be evaluated in light of possible additional inflation signal output delays, as derived from the resulting decoding constraints.

In other embodiments of the system, a RISC-type control

processor, or other fast signal processors as are known in the art, may be used to conduct analysis of signals from receiving antenna (350) after such signals have been suitably filtered and digitized. Software may be used to do simple frequency detection. In addition, algorithms may be used to recognize specific signals for verification of frequency, amplitude, modulation, and/or spectral content of the acquired signal. Redundant hardware and/or processing algorithms can also be used to confirm the presence of a ballistic projectile or concussive wave front, to minimize the likelihood of accidental deployment.

Once the presence of a ballistic projectile has been reliably detected, then the firing circuit (440) is activated. The squib (450) (not shown) is located inside gas generator (210) and is used to ignite the oxidizer therein. The gas generator (or gas generators, since multiple units may be used, depending upon the application) is a Primex 28534-301 (or equivalent) with 68 ft^3 free volume and approximately 1 lb of propellant. The generator is initiated with a squib, such as an M-102 Atlas Match squib (or equivalent) typically using a firing signal of 3 amps or more at 12 volts for a duration of 2 ms or longer.

Tone decoder (430) can be constructed from a conventional LM567C tone decoder integrated circuit, or similar device, and is used to detect the presence of certain frequencies to determine the presence of a Doppler-shifted ballistic projectile signal.

Turning now to Fig. 5, the circuit diagram for tone decoder

(430) is illustrated. As can be seen, tone decoder integrated circuit (460) of type LM567C, or similar, is surrounded by conventional components, the particular values of which are illustrated on the diagram. Individual component values are determined by formulas well-known in the art, and the values shown in the figure are typical for detection of a Doppler-shifted frequency generated by a 9mm bullet. For example, it has been experimentally determined that the range of doppler shift varies from approximately 19 Khz to 26 kHz for a 9mm bullet travelling at speeds of 900 fps to 1200 fps, respectively. For a 5.56 mm bullet, the shift goes from 64 kHz to 73 kHz for velocities ranging from 3,000 fps to 3,400 fps, respectively. Of course, multiple tone decoders, operating simultaneously, can be used in this particular embodiment of the present invention, any one of which is capable of activating firing circuit (440).

Turning now to Fig. 6, a schematic diagram of the gas generator squib ignition circuitry is illustrated, using typical component values well known in the art. Generally, a signal of at least 3 amps at 12 volts must be present for a duration of 2 ms or longer. The propagation delay involved in firing the squib after receiving the validated concussive shock wave or ballistic projectile detection signal is approximately one msec, depending on tone decoder detection time.

Although the invention has been described with reference to specific embodiments, this description is not meant to be construed

in a limited sense. Various modifications of the disclosed embodiments, as well as alternative embodiments of the inventions will become apparent to persons skilled in the art upon the reference to the description of the invention. It is, therefore, contemplated that the appended claims will cover such modifications that fall within the scope of the invention.

CLAIMS

We Claim:

1. A reactive personnel protection system of the type in which at least one air bag is inflated responsive to detection of a projectile prior to contact between said projectile and a person, said system comprising:

a radar-based projectile detection system;

at least one rapidly deployable air bag; and

a gas-generating system for rapid deployment of said air bag in response to detection of the approach of said projectile in proximity to said person by said detection system.

2. The system of Claim 1 wherein said radar based projectile detection system operates at a frequency of 8-20 Ghz.

3. The system of Claim 1 wherein said radar based projectile detection system operates at a frequency of 10.5 Ghz.

4. The system of Claim 1 wherein said rapidly deployable air bag is interposed between said projectile and said person upon deployment.

5. The system of Claim 1 wherein said rapidly deployable air bag is deployed across an opening into a room located between said

person and said object.

6. The system of Claim 1 wherein said rapidly deployable air bag is constructed from an ultra-high molecular weight polyethylene material.

7. The system of Claim 1 wherein said rapidly deployable air bag is constructed from SPECTRA® material.

8. The system of Claim 1 wherein said rapidly deployable air bag is constructed from KEVLAR® material.

9. The system of Claim 1 wherein said radar based projectile detection system has anti-jamming electronics.

10. A reactive personnel protection system of the type in which at least one air bag is inflated responsive to detection of a concussive shock wave prior to arrival of said shock wave at the location of a person, said system comprising:

a shock wave detection system;

at least one rapidly deployable air bag; and

a gas-generating system for rapid deployment of said air bag in response to detection of the movement of said shock wave toward said location of said person by said detection system.

11. The system of Claim 10 wherein said rapidly deployable air bag is interposed between said shock wave and said person upon deployment.

12. The system of Claim 10 wherein said rapidly deployable air bag is deployed across an opening into a room located between said person and said shock wave.

13. The system of Claim 10 wherein said rapidly deployable air bag is constructed from an ultra-high molecular weight polyethylene material.

14. The system of Claim 10 wherein said rapidly deployable air bag is constructed from SPECTRA® material.

15. The system of Claim 10 wherein said rapidly deployable air bag is constructed from KEVLAR® material.

16. The system of Claim 10 wherein said shock wave detection system has anti-jamming electronics.

17. A method to reactively protect personnel from the rapid approach of an object by deployment of an air bag prior to the arrival of the object at the location of said personnel, comprising the steps of:

detecting the approach of said object;

discriminating the presence of said object with respect to the presence of electronic noise;

activation of a gas-generation system in response to discrimination of the presence of said object; and

deployment of an air bag between said object and said personnel responsive to said activation of said gas-generation system.

18. The method of Claim 17, wherein said detecting step is accomplished using a radar-based projectile detection system and wherein said object is a ballistic projectile.

19. The method of Claim 18, wherein said radar-based projectile detection system operates at a frequency of 8-20 Ghz.

20. The method of Claim 18, wherein said radar-based projectile detection system operates at a frequency of 10.5 Ghz.

21. The method of Claim 17, wherein said air bag deployment is accomplished across an opening into a room located between said

personnel and said object.

22. The method of Claim 17, wherein said object is a concussive shock wave.

23. The method of Claim 22, wherein said concussive shock wave is generated by an explosion.

24. The method of Claim 17, wherein said detecting step is accomplished using blast gauges and wherein said object is a concussive shock wave.

ABSTRACT OF THE INVENTION

A counter-terrorism, reactive personnel protection system which detects the presence of a concussive shock wave or ballistic projectile as it approaches a designated personnel target. Before impact, an air bag is rapidly inflated and interposed between the destructive force and the target so as to provide a protective barrier. The air bag is constructed from ultra-high molecular weight polyethylene material, and serves to halt or redirect the detected destructive force and thereby protect the designated target from attack.

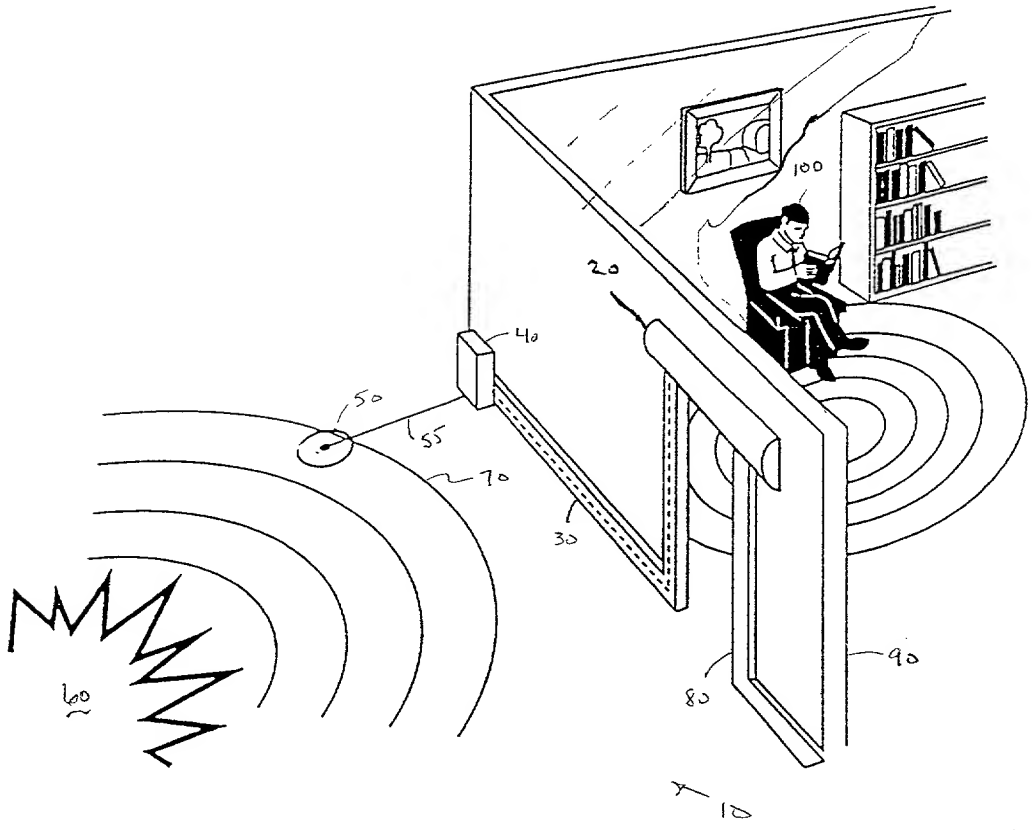


Figure 1a.

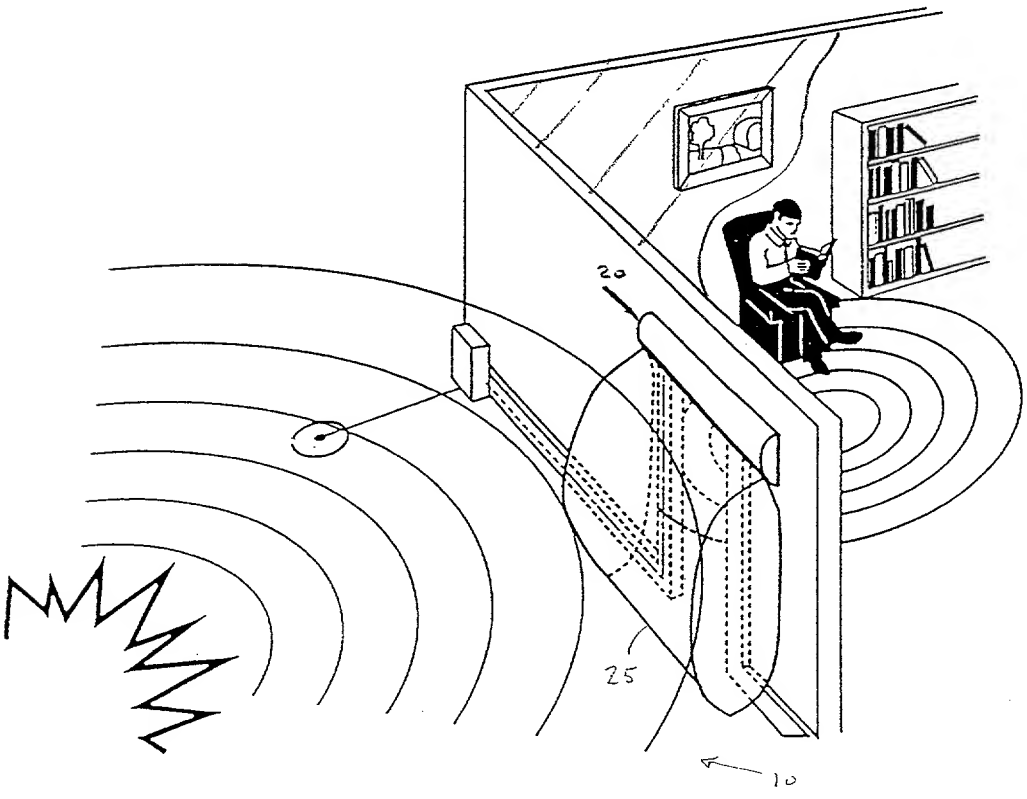
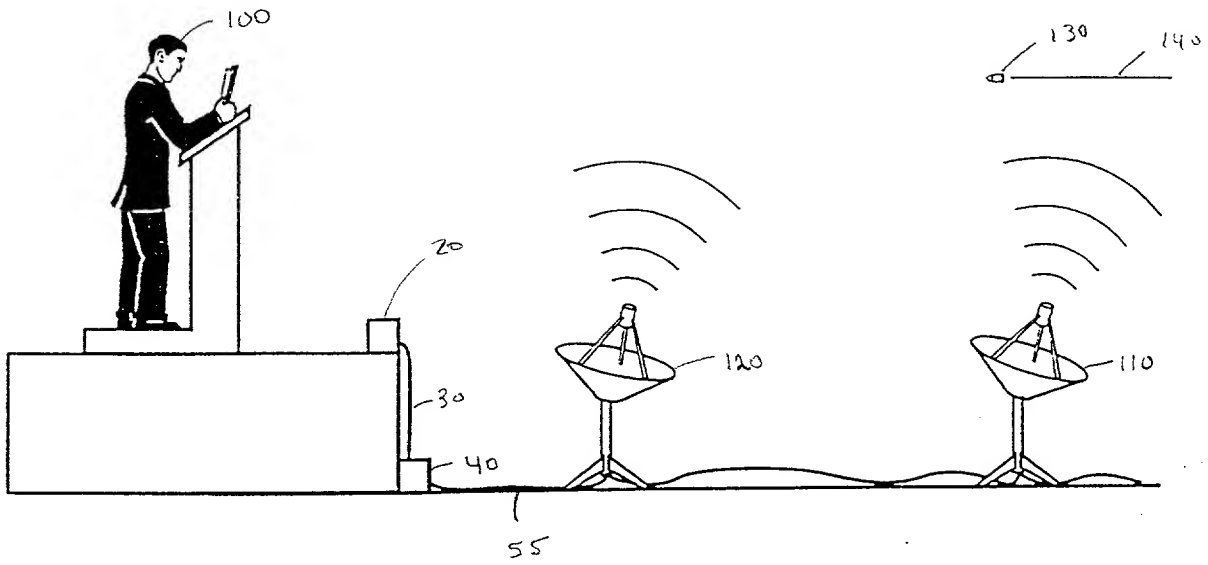


Figure 1b.



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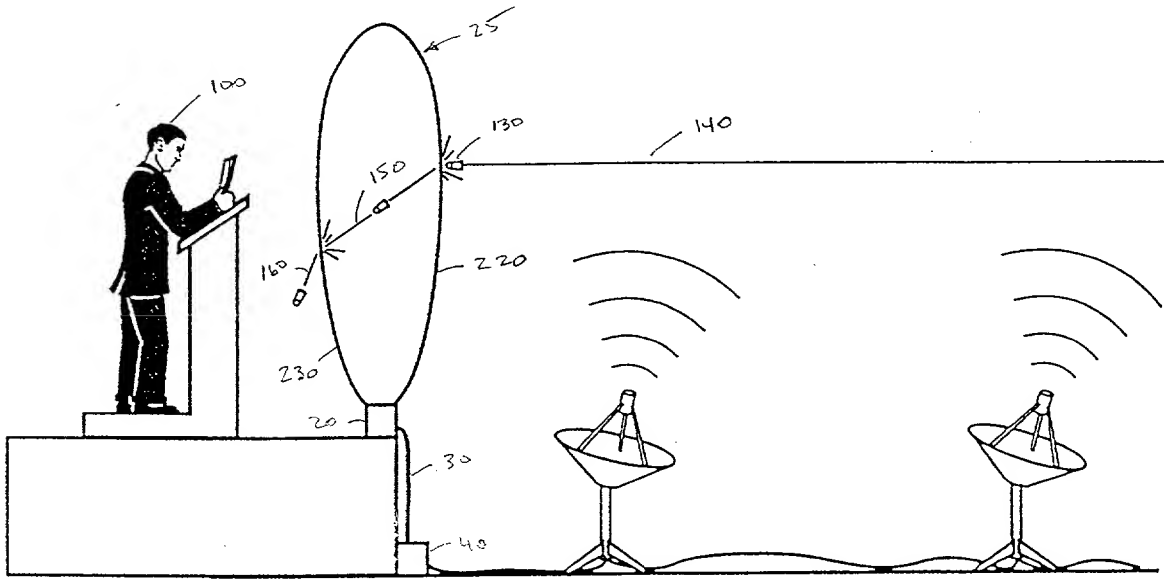

Figure 2b.

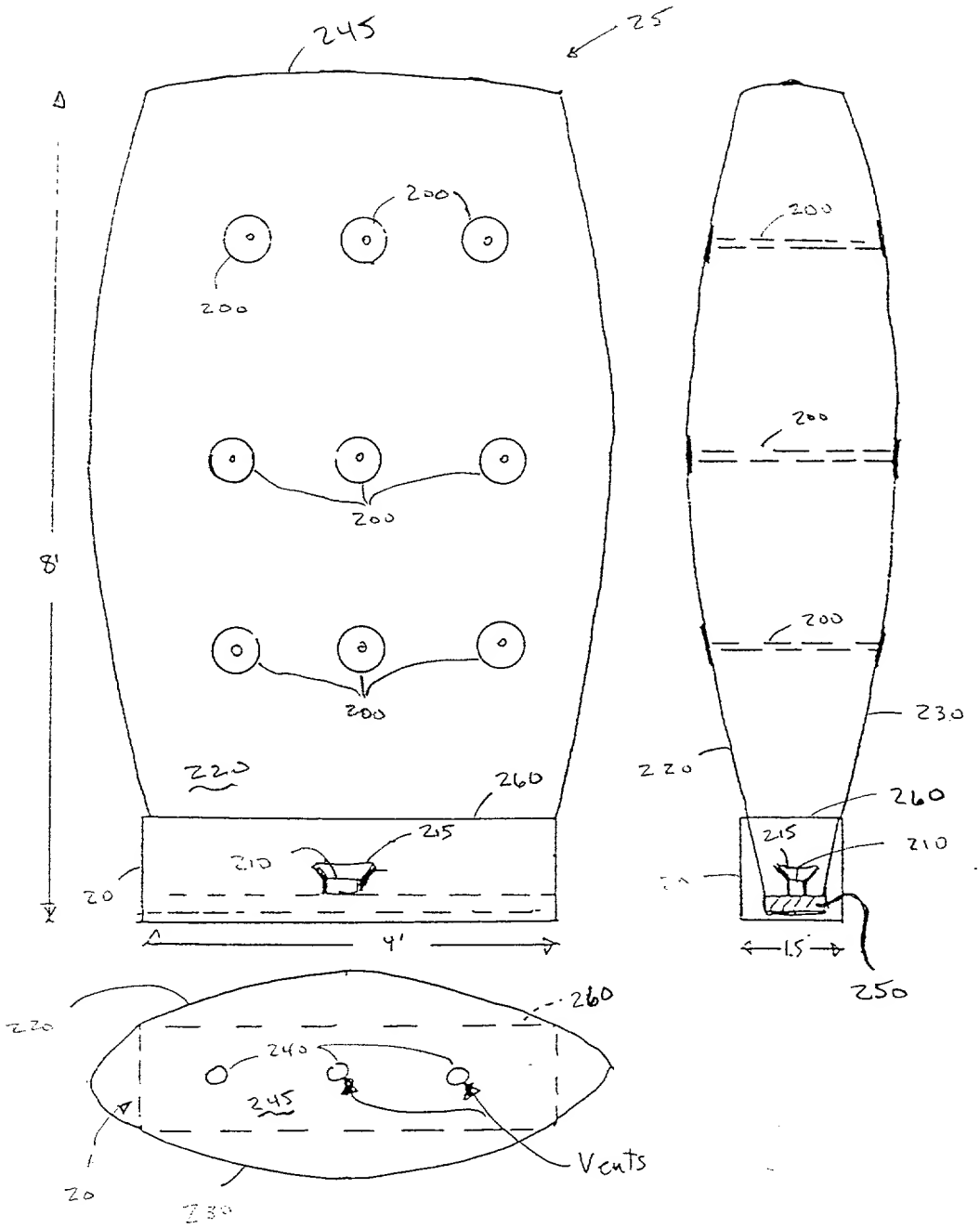
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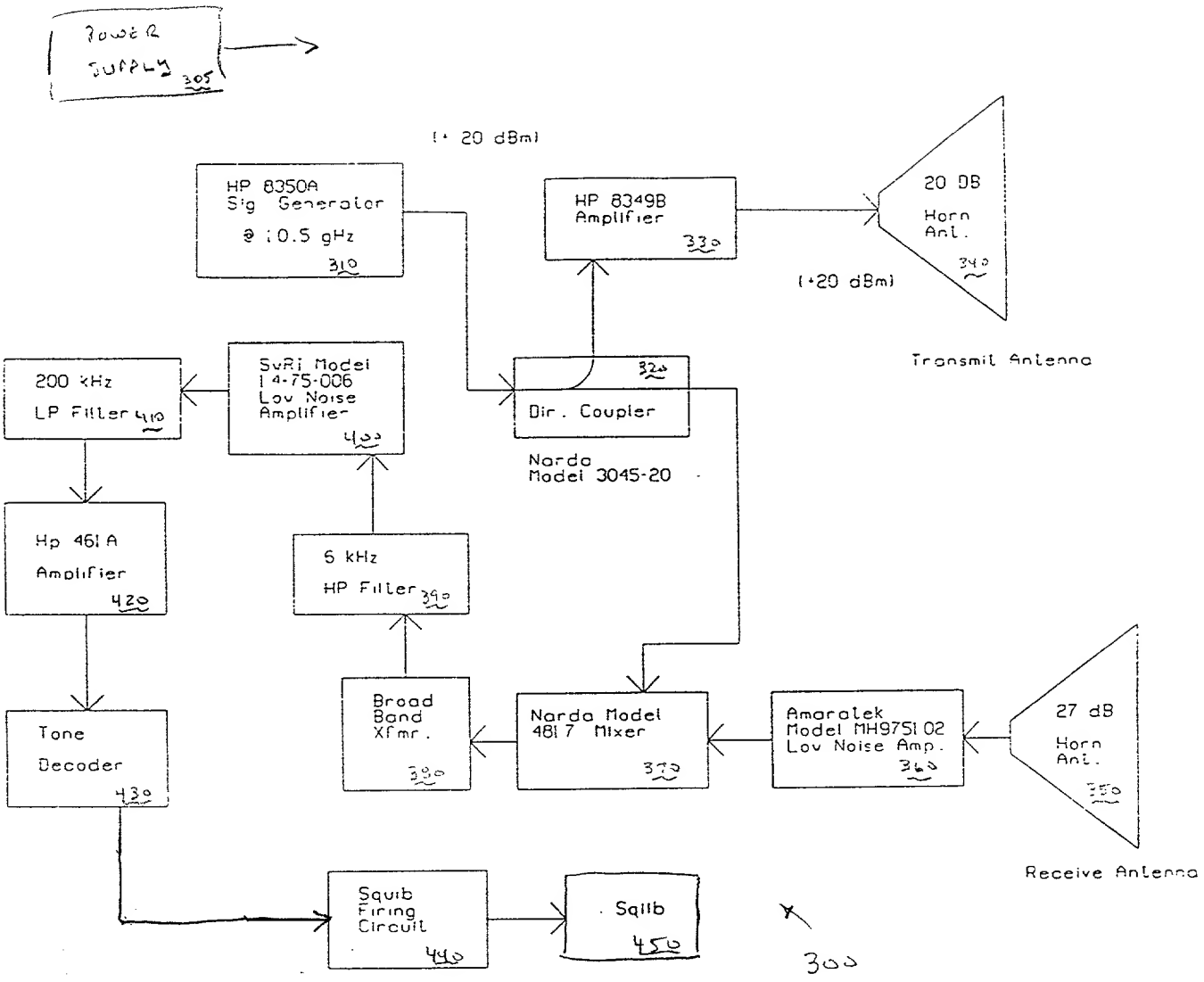
Figure 3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SvRi Model 14-75-006 Low Noise Amplifier 400
320
Dir. Coupler
Narda Model 3045-20
Hp 461A Amplifier 420
6 kHz HP Filter 390
Broad Band Xfmr. 380
Narda Model 4817 Mixer 370
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Figure 4

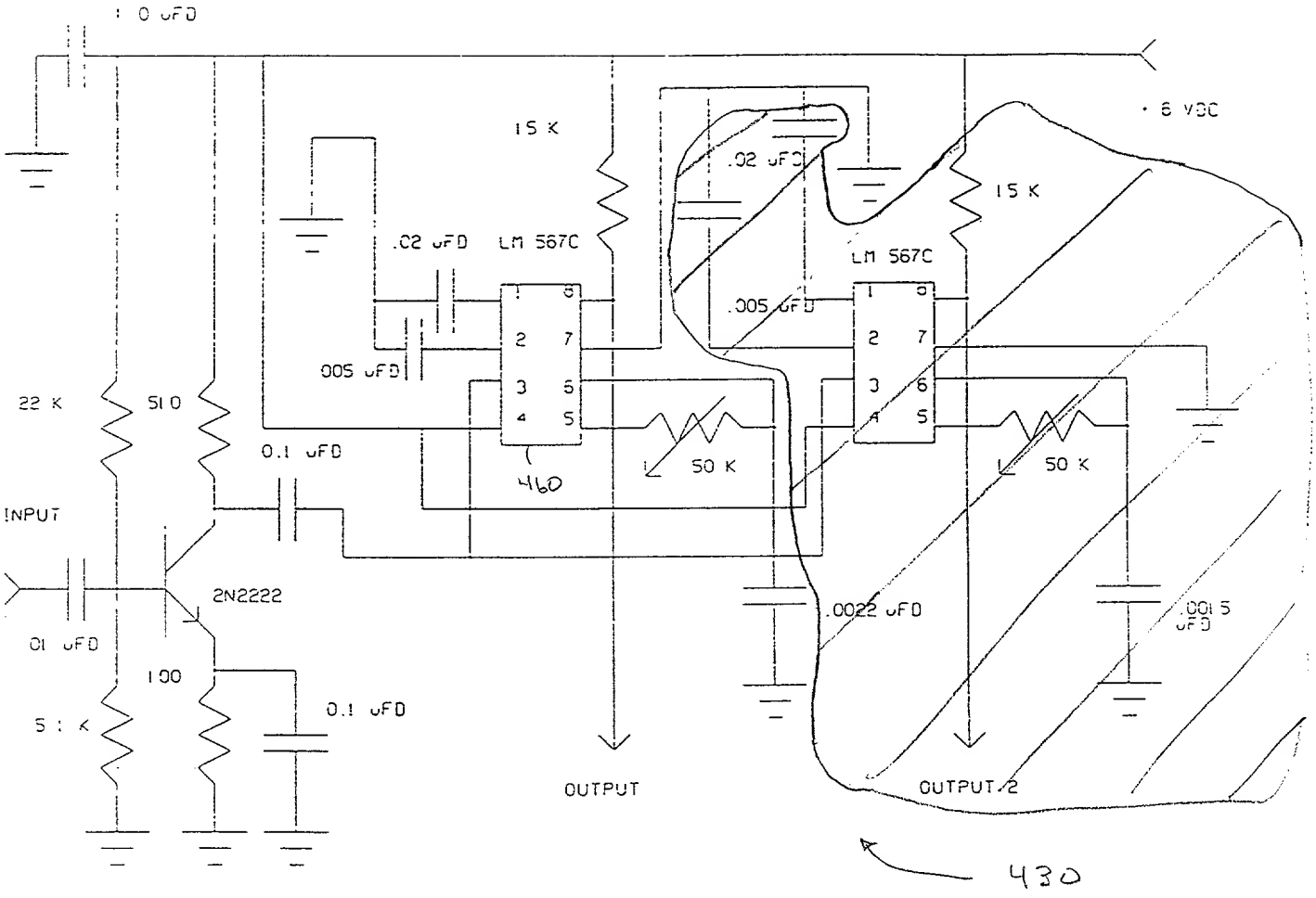
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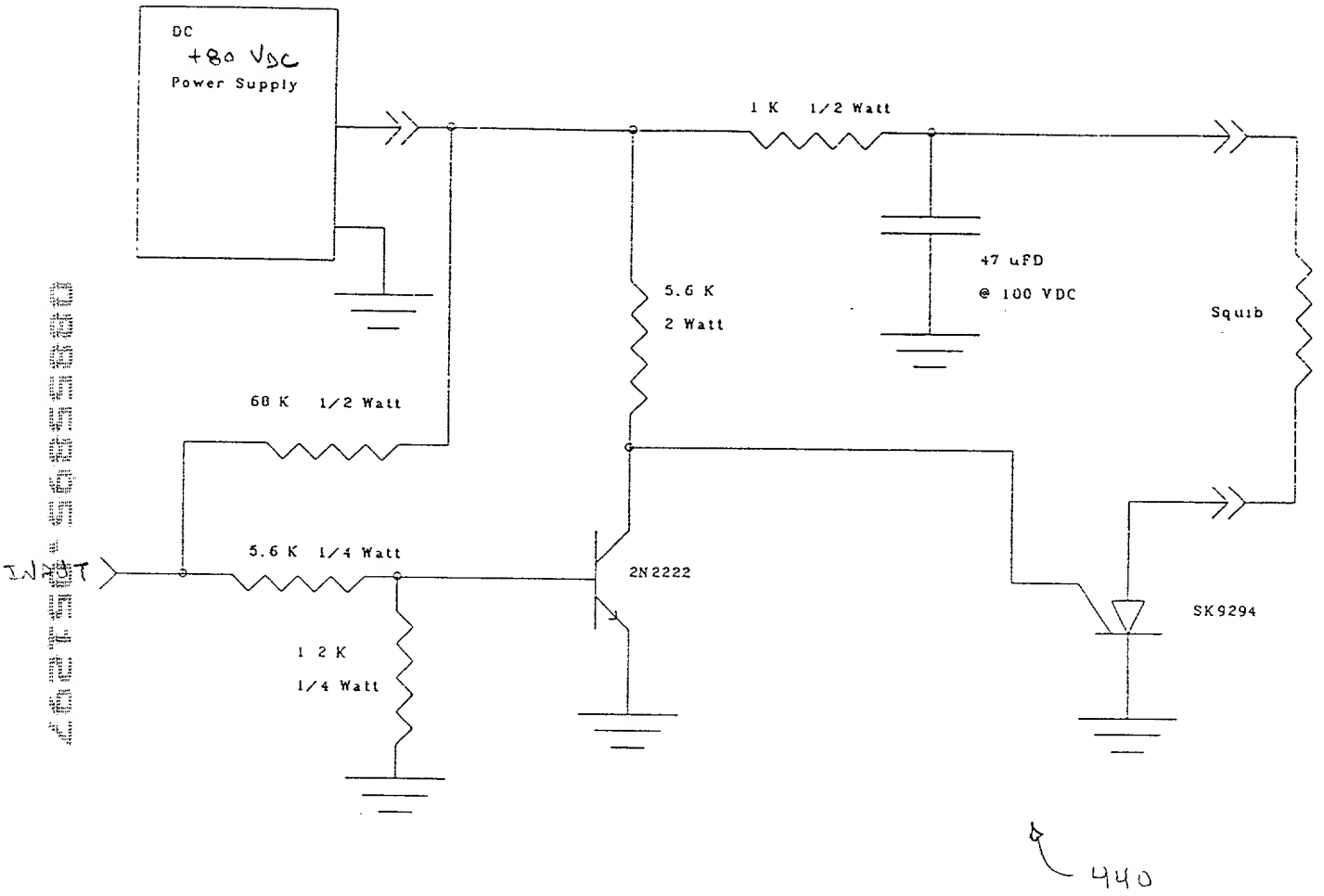
Figure 5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Squib
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2N2222
SK9294
1 2 K
1/4 Watt
440

Figure 6

Docket No. P-17.95

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

[X]	Original	[ ]	Divisional
[ ]	Design	[ ]	Continuation
[ ]	Supplemental	[ ]	Continuation-in-Part (CIP)
[ ]	National Stage of PCT		

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

REACTIVE PERSONNEL PROTECTION SYSTEM

SPECIFICATION IDENTIFICATION

the specification of which:

[X] is attached hereto.

[ ] was filed on _____ as

[ ] Serial No. 0 /_____
[ ] Express Mail No._____

and was amended on _____

[ ] was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____.

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

[X] In compliance with this duty there is attached an information disclosure statement 37 CFR §1.97.

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

[X] no such applications have been filed.

[ ] such applications have been filed as follows:

Earliest Foreign Applications, if any, Filed Within 12 Months (6 Months Design) Prior to This Application

Country	Application No.	Date of Filing (day, month, year)	Priority Claimed Under 37 USC 119

All Foreign Applications, if any, Filed More Than 12 Months (6 Months Design) Prior to This Application

Country	Application No.	Date of Filing (day, month, year)	Priority Claimed Under 37 USC 119

CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S) (34 U.S.C. § 119(e))

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER _____ FILING DATE _____

POWER OF ATTORNEY

As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Mark V. Muller, Reg. No. 37,509
Mark H. Miller, Reg. No. 29,197
Daniel D. Chapman, Reg. No. 32,726
Mark A. Kammer, Reg. No. 34,197
Michael Caywood, Reg. No. 37,797
Ted D. Lee, Reg. No. 25,189
Thomas E. Sisson, Reg. No. 29,348
William B. Nash, Reg. No. 33,743
Pamela B. Huff, Reg. No. 35,901

[ ] Attached as part of this declaration and power of attorney is the authorization of the above-named attorney(s) to accept and follow instructions from my representative(s).

Send Correspondence To:

Mark V. Muller
Gunn, Lee & Miller, P.C.
300 Convent, Suite 1650
San Antonio, Texas 78205

Direct Telephone Calls To:

Mark V. Muller
(210) 222-2336

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

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Inventor's signature David J Stevens

Date 4/25/97 Country of Citizenship: United States

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Inventor's signature _____

Date 4/28/97 Country of Citizenship: United States

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Full name of **third joint inventor**, if any: Thomas J. Warnagiris

Inventor's signature _____

Date 4/28/97 Country of Citizenship: United States

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Post Office Address P.O. Drawer 28510, San Antonio, Texas 78248

ADDED PAGE(S) WHICH FORM A PART OF THIS DECLARATION

[ ] Signature for third and subsequent joint inventors. Number of pages added _____.

[ ] Signature by administrator(trix), executor(trix), or legal representative for deceased or incapacitated inventor. Number of Pages added _____.

[ ] Signature for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR §1.47. Number of pages added _____.

* * *

[ ] Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (CIP) application. Number of pages added ___.

* * *

[ ] Authorization of attorney(s) to accept and follow instructions from representative.

* * *

[X] This declaration ends with this page.

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